ECOLOGY OF THE ITATIAIA RANGE. SOUTHEASTERN BRAZIL

I — ALTITUDINAL ZONATION OF THE VEGETATION

(With 7 figures in the text)

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CONTENTS

I — INTRODUCTION

This work, the first of a series to be published about the Itatiaia Range, has as its objective to delimitate and describe in detail the different vegetation belts, as they occur in the massif.

Research on the Itatiaia Massif and on other high mountains of the State of Rio de Janeiro, are an integrant part of the Project *"Ecological Survey of the Vegetation of the State of Rio de Janeiro"* (*), undertaken by the Museu Nacional, under the sponsorship of the Conselho Nacional de Pesquisas (Brazilian Research Council), to whom we are indebted for financial assistance.

The author started his studies in 1940, exploring the region in the company of several botanists. From 1953 on, the staff of the Project began a detailed study of the region and of other high mountains of the State as well. These studies are still under way.

The author wishes to express his most sincere thanks and deep recognition to the botanist Dr. ALEXANDRE CURT BRADE, who initiated him in the knowledge of the Itatiaia region, for the identification of the plants and discussion of problems concerning the floristic composition. His gratitude is also extended to Dr. PIERRE DANSEREAU, of Montreal, from whom the author learned a great deal during the two trips they made together to the massif in 1946, and to the former and actual members of the staff of the Project *"Eco-*

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logical Survey of the Vegetation of the State of Rio de Janeiro".

II — THE REGION

GEOGRAPHIC POSITITON

Along the southeastern coast of Brazil, a chain of mountains situated within the warm and humid coastal climate runs parallel to the sea. It is in fact constituted of two parallel ranges, which reach, from a very narrow sedimentary coastal plain, altitudes of from 1,000 to 2,300 meters. Between those two ranges flows the Paraiba river which, at first goes from north to south and, in its lower course from south to north, dropping more or less abruptly into the coastal plain. The Paraiba river emerges through a delta into the Atlantic Ocean, at São João da Barra, a town near the city of Campos, in the north of the State of Rio de Janeiro. A large part of its course runs through a sedimentary plain at 400 to 500 meters of altitude, located between the two parallel mountain chaines.

The range nearest to the sea, called the Serra do Mar, has very abrupt slopes, almost vertical, with an average altitude of about 700 meters.

The range further inland, called Serra da Mantiqueira, although abrupt is much less inclined than the Serra do Mar.

In this inland range, (latitude approximately 20° 25' S, longitude 44° 50' W), is situated the Itatiaia Massif, which has an area of about 1,450 km² (Lamego, 1936).

The massif is limited on the south by the valley of the Paraiba river and on the north by the Serra do Picú, Serra Negra, and by the valley of the Rio Preto, which has its headwaters on the eastern side of Serra Negra. Towards the west the massif is limited by the valley of the Rio Salto, that has its headwaters on the southern side of Serra Negra, and flows into the Paraiba river near Vila do Salto. On the east the massif has no well defined limits, merging gradually into the Serra da Pedra Selada, another great massif. The Itatiaia massif contains the second highest peak of Brazil, with an altitude of 2,787.4 meters (fig. 1), known as Itatiaiassú, a part of the Agulhas Negras ridge. This peak forms the border between three states: Rio de Janeiro, São Paulo and Minas Gerais.

PHYSIOGRAPHY

Physiographically, the massif of Itatiaia is constituted of two fundamental units: the slopes and the plateau.

The southern, eastern and western slopes are well defined but not so abrupt as those in the Serra do Mar. Starting from the 400 meter level, they reach an average altitude of 2,000 meters.

The northern slope is less abrupt than the others and reaches a minimum altitude of about 800 meters.

The plateau with an average altitude of 2,000 meters can be divided into three regions: the *Vargem do Aiuruoca,* the *Lower Highlands* and the *Upper Highlands.*

The *Vargem do Aiuruoca* is a broad, flat and boggy plain that occupies the height of land between de Paraiba and the Paraná hydrographic systems. Two rivers originate here: the Aiuruoca that flows eastward and the Rio Preto that flows northeastward.

The *Upper Highlands* are an extremely rough region divided by many small ranges of chaotic aspect. Boulders, some of them from 10 to 20 meters in diameter, lie scattered in all directions, on the hills and in the valleys. The most remarkable part of the range are the Agulhas Negras (fig. 1) and the Prateleiras. They are very abrupt and show considerable evidence of weathering in the polish of their contours, in the curious grooves regularly etched on their surfaces and in the disaggregation of large and small blocks from their slopes. Their altitudes range between 2,000 and 2,700 meters.

In this region there occur several deep valleys with very much inclined sides, such as the Vale do Pinheiral and those surrounding the Morro da Divisa. The valleys situated at the edges of the plateau, and in which most of the rivers run, are always deep, narrow and very steep. The rivers and brooks, which originate in the *Highlands,* all have swift waters, with many falls and drops, some of them ending in dejection fans. The most important among them is the Campo Belo river, which runs through a town known by the same name. The existence of such dejection fans involves the existence of faults (Domingues, 1952). As a matter of fact, at

the Maromba waterfall, at 1,100 meters of altitude, occurs the first fault front; the second is situated at Macieiras, at 1,700 meters. According to DOMINGUES (1952) because of those faults, the massif was raised and afterwards eroded by the weathering agents, which supplied the sediments now deposited in the dejection fans. According to this author, the system of faults is as old as the one that gave origin to the Serra do Mar therefore, Post-Cretaceous.

GEOLOGY

The Itatiaia massif, with an area of about 1,450 km², is one of the largest outcrops of nephelinic rocks in the world.

The dominant rock is a hard, uniform and medium-grained rock of an ash-gray colour, which is a type of nephelinic syenite known as foyaite (LAMEGO, 1936).

As generally occurs in every alkaline massif, the Itatiaia shows a great variety of types of rock. Besides the nephelinic-syenite rocks, which are poor in silica, are found porphyroid phonolite and quartz-syenites, very rich in silica and therefore more acid. Otherwise the ridges that occur in the *Highlands*, are generally formed by a granitic type of rock, such as nordmarkite (LAMEGO, 1936).

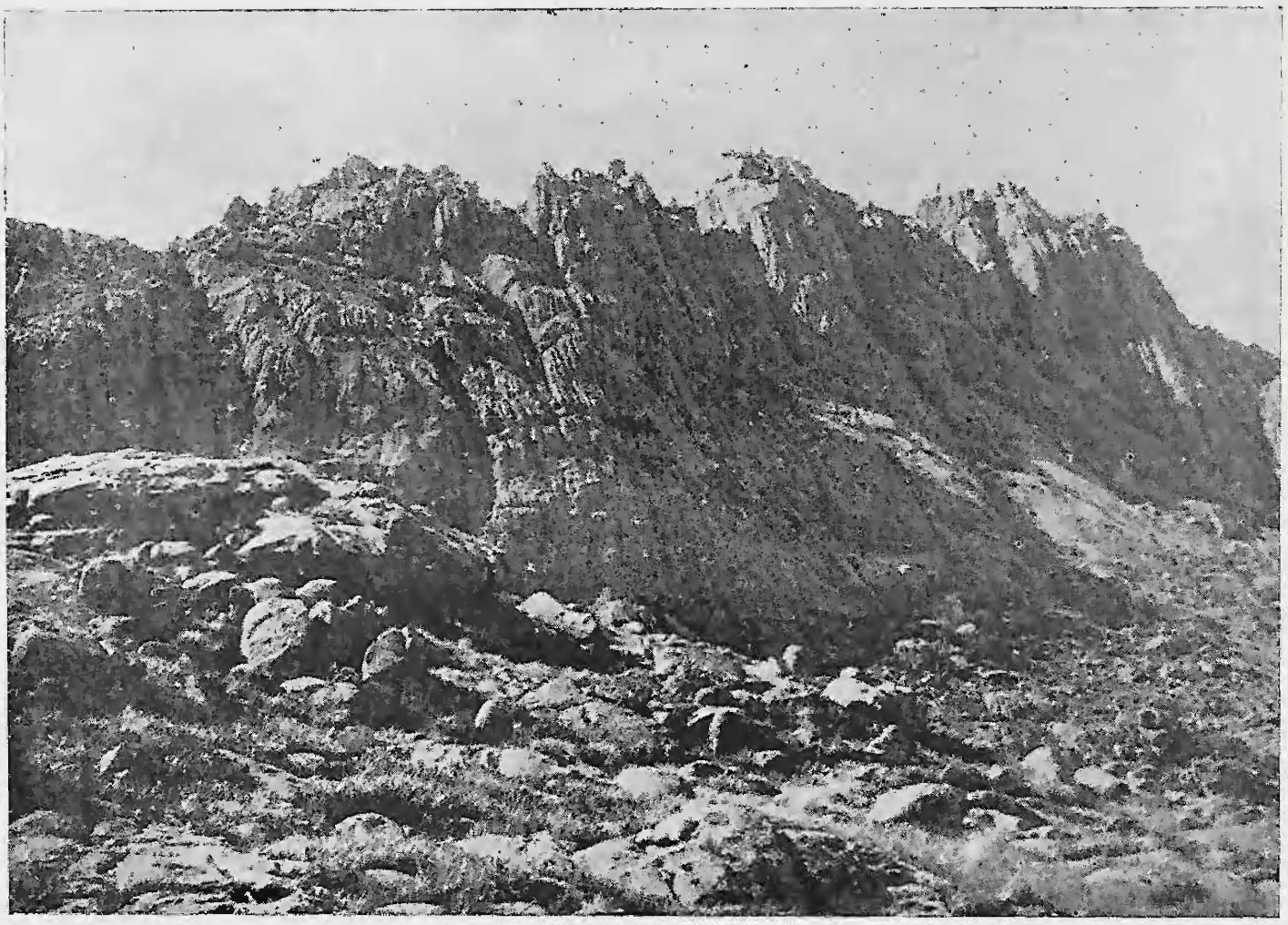

Figure 1 — General view of the Agulhas Negras, showing the tremendous effects of erosion by the chemical action of rain waters.

The *Lower Highlands* are quite different from the *Upper Highlands*. Altitudes range from 1,400 to 1,600 meters. There are many small hills with rounded contours and not over 200 meters of difference in level. The Rio Preto cuts through them and receives many tributaries.

According to what was said above, the Itatiaia massif is formed by extremely hard and predominantly alkaline rocks, except for the ridges in the *Highlands* which are mostly of an acid type.

As to the origin of the massif, opinions vary among the geologists who have studied the region. DERBY (1889) considered the nephelinic and granitic outcrops as being of eruptive origin. According to him, the Itatiaia would be the roots of an enormous volcano, or else the remains of a volcanic region with several chimneys. LEME (1923) on the contrary, thinks that the rocks are of metamorphic origin and that the forces which caused the formation and folding of the coastal gneiss, were also responsible for the formation and uprising of the syenitic masses that form the Itatiaia.

Recently, LAMEGO (1936) and DOMINGUES (1952), refuted the interpretations of DERBY and LEME. Neither author found evidence of volcanic chimneys, nor even of tuffaceous phonolites, basalts or true tuffs. The effusive rocks when present, occupy only small spots. In the same way, they do not accept the supposition that Itatiaia is at the roots of a volcano, for in this case, they ought to find some testimony of it, in view of its relatively recent age.

The genesis of Itatiaia is explained by LAMEGO (1936) and DOMINGUES (1952), through the theory of BACKLUND (1933), according to which a gigantic dome was once formed. In this dome, differentiations occurred during crystallization due to the differential cooling of the several minerals which solidifed. At the time that the magma was fluid, several convective currents were formed, whereas in the walls digestion occurred. The process of solidification of the magma, according to BACKLUND (1933), can be summarized as follows:

a) the magma's temperature goes down below the algerine melting point; crystallization then occurrs and consequent segregation of rock types;
b) high temperatures persist along the full length of the elevated walls; in this way the magmatical differentiation remains and digestion of the walls occurrs;
c) due to the vicinity of the gneissic dome, rocks associated with silica are formed;
d) the top of the dome fractures and intrusion by dykes and hydrothermal formation takes place.

According to LAMEGO and DOMINGUES, the slopes are predominantly foyaitic, while the ridges of the Agulhas Negras, Prateleiras, etc., are predominantly formed by quartz-syenites, showing that it was there that the digestion of the dome took place. The pseudo-stratification observed in these hills, probably originated through the convective currents formed in the interior of the fluid magma.

As for age, both DERBY (1889) and LEME (1923) consider Itatiaia as Post-Permian. REGO (1930) says it is Permo-Carboniferous. LAMEGO (1936), reviewing the whole geomorphological history of the Paraiba valley, and correlating the eruption of the foyaitic magma with the formation of Tertiary basins, is led to consider it somewhat anterior to the sediments of the latter, that is Cretaceous or Eocene. OLIVEIRA and LEONARDOS (1943) place it in the Lower Jurassic.

DOMINGUES (1952) admits that the rocks of the massif were formed in the Lower Jurassic and considers the faults that elevated the massif to such an altitude, as being of a more recent age, or at least Post-Cretaceous.

GLACIATION

Certainly, to an explorer familiar with glaciated territory, there is much in the *Highlands* landscape that is reminiscent of glaciers. It was only recently that DE MARTONNE (1944), in a geomorphological study, opened up the question. He finds plenty of evidence that many forms of relief are to be observed here that do not occur at lower levels in south-eastern Brazil and that do occur in typically glaciated country.

Local glaciations were not rare during the Quaternary. Itatiaia may have been the center of a local glacier. For this, the lowering of a few degrees in the annual mean temperature would be enough. This would place it in the region of eternal snows, since the *Highlands* are almost in the snow zone. In the *Highlands*, series of closed depressions, oriented according to a certain inclination and cut by bars and bolts are very common. From one depression to the other, the drop is sudden. This aspect is characteristically that of an "U" shaped hanging valley, like the valley of "Lirios" and the one of "Flôres"

Cirques are very numerous and sometimes occupy large areas, such as the one that forms the "Vargem do Aiuruoca". The rivers of boulders which are found on the slopes of some of the hills and fill the greatly inclined valleys, have the aspect and structure of moraines

The reluctance of some geologists and geomorphologists who studied the region, to admit local glaciation has been due to the absence of glacial grooves and others glacial morphological features, and to the absence of floristic, faunistic, and palynological documents, capable of corroborating such a theory. As for the absence of glacial grooves, it is not difficult to imagine, in face of the incredible rate of weathering of foyaite and nordmarkite, that they have eroded long ago.

EROSION

Present-day relief-forms on Itatiaia, and specially on Agulhas Negras, certainly show the tremendous effects of erosion (fig. 1). Well polished boulders and stones lie all over the hills and in the valleys. The surface of the bedrock itself is deeply and regularly grooved. These troughs sometimes attain 20 to 25 cm in diameter.

Can it be that the mechanical disaggregation by temperature or the mechanical action of rain, in a relatively temperate climate is capable of producing such effects on hard rock? Such forms are not rare in other regions of soluble limestone where they are corroded by water rich in carbonic acid.

The erosion which modified the aspect of relief is without doubt, of a chemical nature. Tropical regions are characterized by rains rich in nitric acid (Branner, 1896 and Vageler, 1938). This acid is formed by lightning, which produces ozone that combines with free nitrogen in the atmosphere. The data supplied by Branner (1896:308), are estimated from those obtained at Caracas, Venezuela and not actual measures of the rain-water content. W. Freise (1933, apud De Martonne, 1944), verified that at Terezópolis, Serra dos Órgãos, the fog had about 50 cm^3 of water per cubic meter of air, and contained from 15 to 18 mg of carbonic acid and 19 mg of nitric acid per liter.

The *Itatiaia Highlands* are characterized by the great intensity and violence of their electric storms (Segadas-Vianna and Dau, 1965). Consequently, the rain waters on these occasions must be rich in nitric acid. Through its oxydizing power it reacts with the iron of the crystalline rocks, causing its disaggregation. These waters, rich in carbonic and nitric acid, penetrate through the superficial fissures of the rocks and dissolve the feldspars and feldspathoids. Besides the portion taken in dissolution, another part is hydrated and washed out in suspension or under colloidal form. In this way, small alveoli and concavities are formed.

During the cold and dry season, these depressions are dried out. In their interior, over the thin layer of soil, formed through the sedimentation of the constituent elements of the rocks, which were dissolved and not eliminated, are stablished lichens that will develop during the season of medium rainfall. The organic acids then produced have an active role in the deepening and enlargement of these alveoli. With the coming of the rainy season and the occurrence of strong electric storms, these cavities are filled with water rich in carbonic and nitric acids, which will continue the decomposition, now made easy owing to the fissures produced by the organic acids.

The continuation of this process enlarges and deepens the alveolus, until one of the sides is broken, making it look like the drain of a dam. From this drain, a slightly excavated vein is formed and through it the discharged water flows from the alveolus. In the course of time, the veins change into grooves, which normally have a depth of 30 cm. However, in many places as in the Agulhas Negras, they deepen to 50 cm or even to 1 meter. In fact, all grooves have in their upper part a deep and wide depression, resembling a river-made pothole. We prefer to use here the expression "alveolus" instead of pothole, because this last term means a relief form caused by the mechanical erosion characteristic of a young river course. From the above it would seem that the only plausible explanation for the tremendous erosion on Itatiaia is the chemical decomposition caused by rain-waters charged with carbonic and nitric acids. The differential erosion on the blocks, and the different types of alkaline rocks, contribute greatly towards the variety of the topography of this region. Here we could venture the hypothesis that the numerous and deep grooves, which run parallel to each other along

the steep slopes of the Agulhas Negras and of the other ridges, are nothing else but glacial grooves deepened and modified by the constant flow of waters with a high oxydizing power.

III — ALTITUDINAL ZONATION OF THE VEGETATION

EARLIER WORKS

ULE (1895) was the first explorer of the Itatiaia Massif to describe the altitudinal zonation of the vegetation. He delimited and described three main zones, characterizing them by means of a list of the species, which he considered as exclusive for each of the zones. The third zone, the upper one, was subdivided in five units, as follows:

1st zone: lower region, up to 600 meters
2nd zone: forest region, 600-1,700 meters
3rd zone: high mountain or field region
- 1st sub-zone: field region, up to 2,000 meters
- 2nd sub-zone: high-mountain forests
- 3rd sub-zone: high-mountain marshes
- 4th sub-zone: high-fields, up to 2,400 meters
- 5th sub-zone: rocky heights.

At a first glance, this classification is without doubt very useful, in spite of a different criterium being used for the main zones and for the subdivisions of the 3rd zone. Those sub-zones are, above all, ecological units instead of climatic and altitudinal. Also the floristic point of view has prevailed over the vegetational. The explorers who followed, in general, held to ULE's classification. HEMMENDORFF & MOREIRA (1903) used it without accepting, however, the subdivisions proposed for the upper level.

In his excellent work on the Itatiaia birds, HOLT (1928) accepted, with slight changes, ULE's zones. However, he named them according to a climatic nomenclature. The vegetational zonation proposed by HOLT can be summarized as follows:

Tropical zone: — "The Tropical Zone embraces all the foothill region and, due to the removal of the forest, pushes up into the Monte Serrat basin to an altitude of about 3,000 ft., forming a pocket well within the Sub-Tropical Zone".

Sub-tropical zone: — "This is a zone of tall trees, which with the exception noted under the Tropical Zone, includes the whole of the forest region. Its altitudinal extent is roughly from 3,000 ft. to 6,000 ft., with irregular limits above and below".

Temperate zone: — "The ridges, broad slopes, and rocky peaks rising above an altitude of approximately 6,000 ft., lie within the Temperate Zone, which is exactly coextensive with the Campo Region. While the principal floral feature is treeless grassland (Campo) there are many copses of dwarf forests often quite extensive; and on some slopes wide bands of woods, which are really continous extensions of the forest region, reach up from the Sub-Tropical Zone. In these forests the boundary between the Sub-Tropical and Tropical Zones is very difficult to determine exactly, though at the lowest limits of "Campo" it is sharply defined".

ZIKAN and ZIKAN (1940) in the introduction to the catalogue of insects of the Itatiaia Massif, recognized the existence of four altitudinal zones of vegetation. The first, within the levels of 400 and 700 meters; the second, limited by the levels of 700 and of 1,000 meters; the third, going from 1,100 to the altitude of 2,000 meters; and finally the fourth, which includes the *Highlands* and the high peaks, that is to say, the band limited by the levels of 2,000 and of 2,770 meters.

The Itatiaia bibliography is above all rich in papers related to the description of new botanical taxa. The only papers concerning the whole flora are the ones by ULE (1895), DUSÉN (1905, 1909a and 1909b) and BRADE (1942). The latter, also describes some aspects of the vegetation. The only botanist who dedicated a great deal of his work to the study of the flora, was A.C. BRADE, of the Rio de Janeiro Botanical Garden who up to 1954 published 24 papers on this region.

In connection with the fauna, there are relatively few papers. The only articles concerning the whole fauna are the ones by MIRANDA-RIBEIRO (1905) and BARTH (1957). The others are studies about certain groups of animals such as those by MIRANDA RIBEIRO (1923), HOLT (1928), ZIKAN and ZIKAN (1940, 1946), PINTO (1954), LUTZ (1958) and LUTZ and LEITÃO DE CARVALHO (1958).

The article by BARROS (1947), ex-Director of the Parque Nacional do Itatiaia (Itatiaia National Park), gives a great deal of useful information about several aspects of the region, and the one by HOLT (1926) gives a list of the bibliography, up to 1926.

ZONATION OF THE VEGETATION

When delimitating and defining the several vegetation levels, we have tried not to emphasize "a priori" the importance of any of the environmental factors. The altitudinal vegetation belts were delimited considering three basic elements: vegetation, physiography and climate.

In the analysis of the vegetation, the following elements were taken into consideration: structure and, in consequence, physiognomy; dynamical status of the physical environment and, therefore, of the community that occupies it; dominant species; floristic composition, and internal ecological conditions of the community. The dynamical status of the physical environment, i.e. the phase of the geomorphological evolutionary process in which it is found the community, defines the substratum and micro-relief conditions of the environment. Consequently it determines, not only the floristic composition and therefore dominance, but also all the structural and physiognomical characteristics of the community which occupies it. The elements: dominant species, floristic composition and internal ecological conditions, have been used only in the definition of the communities, since they depend directly, not only upon climate and physiography, but also upon the available flora, which, in turn, derives from the geological, geomorphological and climatic history of the region. In other words, we may find in climatically and geomorphologically identical habitats, but geographically remote from each other, communities ecologically homologous with entirely different dominance and floristic compositions.

The first step in the delimitation of the vegetational belts was to establish the structure that prevailed in the vegetation occurring at the various altitudes. The second step was the study of the geomorphological evolutionary processes, and the analysis of the vegetation that occurred at the places where those processes have reached their maximum, or better, in the geomorphologically stabilized environments. After determining the altitudinal seriation of the physiognomic structural types of vegetation, we proceded to verify if in fact there exists a direct correlation between this seriation and the climates. The results obtained through the study of the climates (SEGADAS-VIANNA and DAU, 1965), shows that in fact there is a direct relation between the altitudinal distribution of the vegetation types and that of the climates.

In the designation of the levels we tried to use a nomenclature that would not be tied to any specific environmental factor, especially the climatic ones. We therefore decided to use a nomenclature which would refer to the vegetational belt's position in relation to the total altitude of the mountain. The same belts occur in other tropical mountains, within different altitudinal limits, and, obviously with a vegetation whose physiognomic-structural characteristics differ a great deal from those described here.

In function of the above cited elements, six main vegetational belts have been delimited and defined, as follows:

Plain Level	— from	400 to 700 meters
Lower Montane Level	— from	700 to 1,100 meters
Middle Montane Level	— from	1,100 to 1,700 meters
Upper Montane Level	— from	1,700 to 2,000 meters
Highlands Level	— from	2,000 to 2,400 metres
Summits Level	— from	2,400 to 2,770 meters

IV — THE PLAIN LEVEL

During the colonial period, this level was covered by a dense tropical forest with a structure and composition similar to the present forest on the Serra do Mar escarpments, at the same altitude. This region being much drier and warmer than the seaward escarpments of the Serra do Mar, the climax forest would have a more open structure, and probably also some of the lower strata, mainly the shrubby layer, would be absent or poorly developed.

Nothing is known about the floristic composition of the former forest since no stands of the original climax have been preserved.

The primitive forest was cut down by the first colonists for the establishment of coffee plantations. In the middle of the XIX century, the town of Resende was perhaps the greastest center of coffee exportation of Rio de Janeiro State. At this time, there were in Resende nine warehouses and five in Vila do Itatiaia, located at the base of the massif (LAMEGO, 1950). At the end of the XIX century, the coffee farms were abandoned and replaced by sugar-cane plantations.

The coffee groves gradually deteriorated until they were replaced by a community of

typical physiognomy, which is dominated by the melastomaceus *Clidemia neglecta.* This species is a low shrub with a very dense round-shaped crown that touches the ground, and of a brownish color. The individuals are arranged at distances that vary from two to three meters. This community is an excellent index, since the species behaves as dominant only under these conditions. Normally, it is only an unexpressive component of the wood's edge or of the clay cliffs.

At the beginning of the XX century, due to the intensification of the erosion of the round-shaped hillock and the consequent soil degradation, sugar-cane production decreased until the plantations were abandoned, and the whole region entered the cattle-raising cycle. During this period, the big coffee farms were also abandoned, and the few that remained active dedicated themselves to marginal cattle-raising. The pastures were maintained as they are today, by the use of fire. Under no conditions do the present land-owners fertilize the soil or establish artificial pastures. Thus, almost all the vegetation cover of the region is maintained in the pioneer stages of secondary succession, a fact that dates back to the beginning of the present century. This behaviour of the land owners, allied to the intense hillock erosion, has impeded the progression of plant succession beyond the pioneer stages.

At certain places, where action of fire has been less severe, the soil is covered by a low and dense vegetation, exclusively constituted by the grass *Melinis minutiflora,* commonly known by the name of "Capim gordura". This grass, introduced in Brazil probably from Africa and naturalized here, is a plant with a high degree of competitive power, which eliminates every other grass and even the woody species. These communities of *Melinis* are utilized and maintained by the land owners, through the use of fire, because of its high value as fodder.

In relatively flat places and on the flat hill tops, where erosion intensity is low, the vegetation evolves from the pioneer stages until it reaches a community with a forest structure.

The vegetation which succeeds the pioneer graminoid communities is constituted of woody and herbaceous plants that never reach more than 50 cm of height. The dominants are, as a rule, species of the genera *Pavonia, Sida* and *Triumfetta.* The other components are species of the genera: *Solanum, Capsicum, Diodia, Borreria, Cuphea, Cordia, Leandra, Miconia, Baccharis, Vernonia, Eupatorium,* etc.

The next stage in the successional process is a shrubby and very open savanna-type of vegetation, not more than about 4 meters in height. The lower stratum is constituted by a low grass carpet dotted with woody and herbaceous plants. The several communities which compose this physiognomic type of vegetation are dominated by several species, the commonest being: *Baccharis schultzii, Cordia curassavica, Schinus terebinthifolius, Vernonia diffusa* and *V. oppositifolia.*

If fire has been prevented and the physiographic conditions are favourable the vegetation described above evolves to a denser and higher type, commonly known as "capoeira alta". The height of the trees varies from 10 to 12 meters, and their crowns are dense and hemispherical. They grow so close together that it is impossible for a person to penetrate through them. The lower strata are also dense and constituted by species of the solanaceous genera *Capsicum, Cestrum, Nicotiana* and *Solanum* and by the melastomaceous genera *Leandra* and *Miconia.*

This vegetation is composed of numerous communities generally dominated by more than one species. The most common are: *Pisonia nitida, Psychotria hancorniaefolia, Baccharis schultzii, Piptadenia nitida, Inga affinis* and *Cecropia* spp.

Among the components of the stratum immediately below the upper layer, the most important are the palms *Attalea indaya* and *Astrocaryum aculeatissimum* (= *A. ayri*). When the "capoeira" is cut down and burned, these two palms stand out in the landscape. *Attalea* is not affected by fire, which even stimulates its germination. Thus, during many years the region that was occupied by the "capoeira" remains covered by a dense vegetation exclusively dominated by *Attalea indaya.* When fire action has not been excessive, *Astrocaryum aculeatissimum* remains, and intermixed with *Attalea,* lends a special physiognomy to those environments. During the felling of the secondary woods for making of charcoal or clearing the land for agricultural use, *Astrocaryum* is usually preserved from destruction by the simple fact of having the trunk and leaves covered by long and

acute thorns. The tools used for land clearing, the hatchet and the scythe, make the felling of the palm trees difficult without having personal accidents. Another reason for the workers not to cut down those trees, is that they work bare-footed and the thorny trunks would remain dangerously on the ground.

At the upper part of this level, where the climate is much more favourable and where the effects of erosion are not so intense, the already described vegetation is replaced by an open forest whose dominants are from 15 to 20 meters in height. The lower layers are well defined and not very dense. The crowns of the dominants are almost flat, and branching occurs on the upper part of the trunks. Among the several communities which compose this vegetation, commonly known by "capoeirão", the most characteristic one, not by its ecological role but mainly by its physiognomic appearance, is the one dominated by *Tibouchina estrellensis* and *Cassia multijuga*. The flowering of these two species is successive, both bearing per individual a great number of flowers, uniformly distributed over the crown. The first mentioned species has purple flowers, while the second has yellow ones. During the flowering season, these forests are first completely colored with purple and then with yellow. At a certain time during the season, simultaneous flowering of the two species occurs.

The other communities, of a less characteristic physiognomy, than those already described, are dominated by *Croton salutaris, Sclerolobium rugosum, Virola bicuhyba, Hortia arborea* and *Xylopia brasiliensis*.

V — THE LOWER MONTANE LEVEL

On the southern slope of the massif, this level is at present covered by sub-climax woods of different ages. Only on well protected sites, in deep valleys and in certain uncolonized regions, such as Rio Bonito, can stretches of the original climax forest still be found.

From 1908 to 1918 this zone was occupied by colonists of German origin. The colonization was undertaken by the federal government, which intended to establish orchards of temperate zone fruits. Besides the zone of Monte Serrat small pieces of land were given to the colonists, at 1,800 and at 2,000 meters of altitude, where apples and pears were planted. On the northern slope, near the Serra Negra, at about 1,600 meters of altitude, a population of Finns was established.

Unfortunately, the colony was a failure, and its only result was the destruction of the primeval forest. This was due in the first place, to the selection of the imigrants, the majority of whom were not farmers and, in the second place, to the heavy and cold soils of the region. The few colonists who did try to cultivate them abandoned the land and went to the cities after five years. Unfortunately, those who stayed longer dedicated themselves to the destruction of the forests, in order to produce charcoal, railroad ties, and timber for the sawmills.

The most frequent plant community at this level, is the one that has been described for the lower level and is dominated by *Tibouchina estrellensis* and *Cassia multijuga*. Another frequent community, which is successionally much more advanced than the previous one, is the one dominated by *Miconia candolleana* and *M. sellowiana*.

The old secondary forests (fig. 2) are no longer dominated by one or two species, but by an assemblage of species. Among the dominants, the ones that stand out not only by the number of individuals but also by the color of their flowers are: *Vochysia* spp. (yellow flowers), *Erythrina mulungu* (red flowers), *Tibouchina arborea* (purple flowers) and *Meriania claussenii* (purple flowers). However, the components that physiognomically characterize these woods are: the palm commonly known as "jussara", *Euterpe edulis*, whose altitudinal limit is at the level of 1,200 meters, and the "embaúbas" with their silvery leaves, *Cecropia* spp. *Euterpe edulis* replaces, at this level, *Attalea indaya* and *Astrocaryum aculeatissimum* which are characteristic of the old secondary woods of the previous altitudinal level.

The edge of the woods is generally occupied by a dense belt of bamboos, mainly of the genera *Merostachys* and *Guadua*. When submitted to the action of fire, the bamboos of the genus *Merostachys* grow very fast and in such a way that they completely cover the crowns of the trees.

This forest, whose trees have a height that varies from 30 to 40 meters, is relatively open and the lower strata are not very dense but are well defined. The branches of the trees are covered by mosses, lichens and se-

veral others epiphytes. The most frequent components are: ferns of the genera *Hymenophyllum, Trichomanes, Polypodium, Asplenium* and *Vittaria;* aroids of the genera *Anthurium* and *Philodendron;* bromeliads of the genera *Quesnelia, Vriesia, Aechmea* and *Tillandsia;* cacti of the genera *Rhipsalis* and *Hariota;* gesneraceous of the genera *Hypocyrta, Codonanthe* and *Corytholoma,* and many orchid genera. This wood is also rich in lianas, not only regarding the number of individuals but also regarding the number of species.

The best represented genera are: *Bauhinia, Smilax, Herreria, Strychnos, Mandevilla, Arrabidaea, Clytostoma, Heteropteris* and *Philodendron.*

The middle layer is occupied by well-branched shrubs that vary from 3 to 6 meters in height, and have hemispherical or cylindrical crowns. The trunks are thin and straight. The individuals grow relatively far from each other. The constituent species belong chiefly to the genera: *Nectandra, Eupatorium, Vernonia, Erythroxylum, Pisonia, Eugenia, Coccoloba, Psychotria, Palicourea, Cestrum, Ouratea* and *Rapanea.*

The lower layers are constituted by a continuous carpet of mosses and herbaceous plants or by colonies of grasses, sedges and other herbaceous plants, over which groups of small shrubs become established.

The plants that form the continuous carpets are mainly species of the genera *Pilea, Coccocypselum, Peperomia, Selaginella* etc. The herbaceous ones belong to the genera *Scleria, Rhynchospora, Olyra, Pharus, Gleichenia, Lycopodium, Anthurium, Dichorisandra,* etc. The most frequent shrubs are species of the genera *Abutilon, Tibouchina,*

Figure 2 — Old secondary forest at the **Lower Montane Level,** with silvery-leaved **Cecropia.**

Cuphea, Sauvagesia, Vernonia, Buddleia, Croton, etc.

The successionally most advanced communities have their lower layers dominated almost exclusively by herbaceous plants with large leaves, such as *Heliconia, Calathea, Maranta, Costus* and *Canna.*

Along the margins of the rivers that cross these woods, and also at the edges and clearings, large colonies of tree-ferns can be found. The most frequent species which dominate under these conditions are *Alsophila elegans* and *Cyathea gardneri.*

in height, wide-open, with a poorly-developed undergrowth, composed of trees with buttress roots and flat crowns. The branches are covered by tight masses of epiphytes, and the trunks by lichens and mosses. The lianas are extremely abundant.

The forest floor is practically bare. At certain spots there are clumps of cyperaceous and shrubby woody plants.

Its most important dominants are *Cedrela fissilis, Cariniana excelsa, Cabralea eichleriana* and *Callichlamys latifolia.* The other tree components are species of the genera:

Figura 3 — Edge of the woods at the **Middle Montane Level,** with the characteristic tree-ferns.

One of the characteristics of the undergrowth is the presence of low palms, *Geonoma schottiana* and *G. barbosana,* of about 1 meter in height and with an extremely thin trunk.

The climax, well represented in the Rio Bonito region, is a forest of 30 to 40 meters *Nectandra, Jacaranda, Tecoma, Cybistax, Canella, Couratari, Machaerium, Copaifera, Qualea, Vochysia* and *Bombax.*

VI — THE MIDDLE MONTANE LEVEL

The vegetation that covers the greater

part of this level is an open climax forest, whose trees have a size that varies from 20 to 30 meters. This forest is not only characterized by the absence of certain species that are found at the previous level, but also by the considerable increase in the number of individuals of certain species, that are also found at the previous altitudinal level. The undergrowth is dense, especially the shrub layer. The most frequent components are *Drimys winteri, Roupala lucens, Weinmania discolor* and *Rapanea gardneriana.*

The number of epiphytes and of lianas is far greater than at the previous levels, and so are the epixylous and terrestrial mosses and liverworts.

The dominants are species of the genus *Cabralea* of which the commonest is *C. eichleriana.*

The subclimax which occupies the greatest area is the one dominated by the purple-flowered melastomaceous species *Tibouchina fissinervia.*

The palm *Euterpe edulis* and the *Cecropia,* characteristics of the previous levels, are absent at this level. Another important modification is the low frequency of palms of the genus *Geonoma.* The only species that occurs is *Geonoma schottiana,* and this in a small number of individuals.

The thick bamboos characteristic of the wood edges of the lower levels, are replaced here by thin-stemed species of the genera *Merostachys* and *Chusquea,* that sometimes behave as lianas, climbing up to the tree-crowns. The tree-ferns are represented by species with low and thick trunks, such as *Dicksonia sellowiana, Hemitelia capensis* and *Alsophila elegans,* a very common species at the previous level, whose altitudinal limit is the level of 2,000 meters(fig. 3).

VII — THE UPPER MONTANE LEVEL

The climax of this level is a low and not very dense forest, whose components never rise to more than 15 meters in height (fig. 4). The crowns are characteristically hemispherical, and branching occurs much nearer the ground than at the previous level. Lianas are practically absent. The branches of the trees are covered with dense masses of bromeliads, generally of the genera *Quesnelia* and *Vriesia.*

Mosses are very abundant, covering not only the branches and trunks, but also the forest floor. The dominant tree is *Cabralea eichleriana.*

The shrub stratum is extremely dense and composed mainly of: *Drimys winteri, Leandra, Psychotria, Weinmannia, Roupala* and *Rapanea.*

One of the most frequent subclimaxes and one that also has a conspicuous aspect is the one dominated by *Croton urucurana,* which is commonly found associated with *Weinmannia discolor* and *Drimys winteri.* The trunks of the *Croton* individuals are entirely covered by red-colored lichens of genus *Chiodecton.* The *Croton* leaves are also of a reddish color, a fact that gives a characteristic aspect to this plant community.

During the successional process, the *Croton* subclimax is replaced by a forest whose dominants are species of the genus *Miconia,* associated with *Cabralea eichleriana.*

The edges of these woods are generally occupied by dense colonies of *Tibouchina organesis* var. *silvestris,* a melastome with big purple flowers.

The natural and the man-made clearings are rapidly occupied by a vegetation whose dominants are *Senecio glaziovii, Solanum itatiaiae* and *Vernonia* sp. This community is very dense and has an average height of 4 meters.

In humid and shady places, can be found colonies or isolated individual tree-ferns. The species are the same as for the previous level. As one approaches the upper limit of this level, the forest becomes lower and open, until it is not more than 4 or 5 meters high. The undergrowth becomes thinner and thinner. The few existing lianas disappear. Epiphytism decreases, but never entirely. The epiphytic and terrestrial mosses become rare, disappearing at the highest points of the level.

The causes of this reduction in the height of the woods and its absence at an altitude that at other tropical regions would be occupied by forests, are discussed in detail on the second article of this series (SEGADAS-VIANNA and DAU, 1965).

VIII — THE HIGHLANDS LEVEL

The vegetation of this level, whose topography is very irregular and varied, may be grouped into three physiognomic-structu-

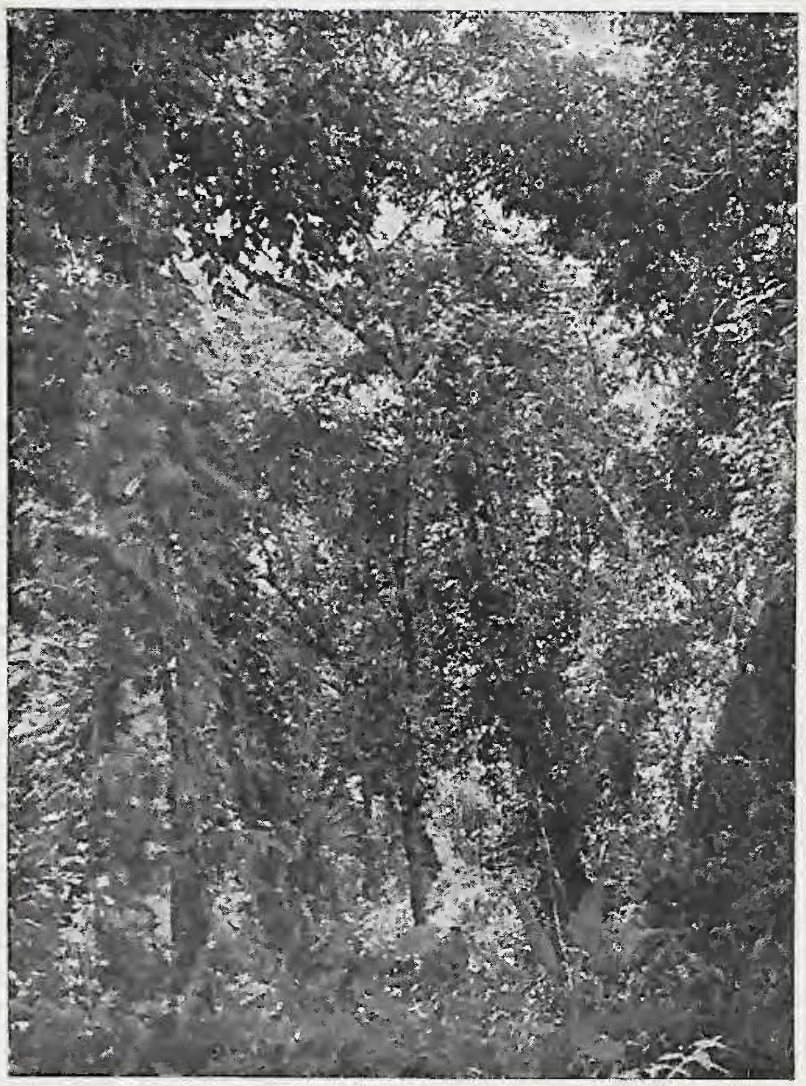

Figure 4 — Structure of the climax forest of the **Upper Montane Level.**

ral types: grasslands, bogs and woods (figs. 5, 6 and 7). Certain parts of this region were settled for the establishment of orchards, which were abandoned in view of the lack of economic returns. These orchards were located in two valleys that were once covered by woods.

The orchards led to the destruction of the planting of fruit-trees but also to the felling for fire-wood. These two places are known in the regional botanical literature as Macieiras do Meio and Macieiras de Cima or Macieiras do Couto.

The greatest part of the *Highlands* is covered by bogs of several types. The level and well-drained areas are occupied by grasslands with a structure similar to the one of a steppe. This type of vegetation is the climatic climax of this level, as will be discussed at length in the second article of this series (SEGADAS-VIANNA and DAU, 1965).

Due to the great number of communities, it has not yet been possible to determine precisely which is the climax community, among the ones of a steppe structure. The grasslands occurring at level, well drained and deep soil areas, and on slightly inclined slopes, are exclusively dominated by grasses. Their height is in general around 20 cm. The most common components are: *Danthonia montana, Briza brasiliensis, Panicum demissum, P. setifolium, Andropogon incanus, Bromus brachyanthera, Calamagrostis montevidensis, Deschampsia* sp., *Festuca* sp., and *Trachypogon* sp. Occasionally, in the interior of these communities, can be found isolated individuals of woody species whose height varies from 3 to 4 meters. The trunks are

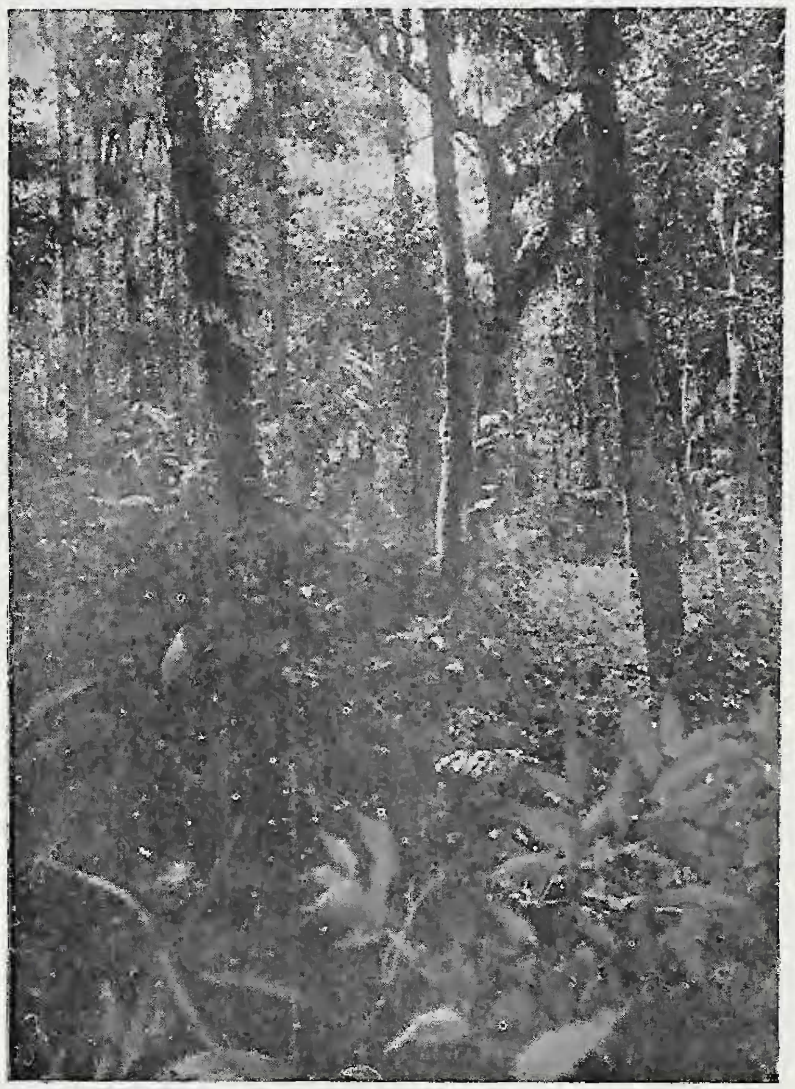

Figure 5 — Structure of the dwarf forest dominated by **Roupala lucens**, at the **Highlands Level.**

tortuous and the crowns irregular and not very dense. They are always found near boulders. The roots are located near the base of the boulder and the trunks follow the round surface of these rocks.

The most commonly found species are: *Roupala lucens, Rapanea schwackeana, R. gardneriana, Weinmannia discolor, Clethra laevigata.* The theaceous *Haemocharis semiserrata* and the magnoliaceous *Drimys winteri* also occur, but rarely.

The well-drained and strongly inclined slopes are occupied by two shrubby communities. These communities, with a maximum height of 3 meters, have a structural type similar to the one of a savanna. The shrubs growing far from each other, have a dense and spherical crown. The ground layer is constituted by a carpet of grasses. One of the communities is dominated by *Baccharis discolor* and the other, more mesophytic, is dominated by *B. platypoda.*

The well-drained slopes, with a low amount of organic matter in the soils, and with an inclination of not more than 5%, are covered by a very dense and almost impenetrable vegetation, with a maximum height of 2 meters. The constituent communities always have a single dominant, the dwarf bamboo: *Chusquea pinifolia.* These communities cover large areas at this level, giving a singular physiognomy to the landscape.

The flat zones and the badly drained but not boggy slopes, are occupied by a dense graminoid vegetation, 1 to 2 meters in height and dominated by *Cortaderia modesta* (fig. 6). The distances between the individuals vary from 50 cm to 1 meter. This grass, of andean

origin, is a tall bunch-grass and its pseudo-trunks, formed by the rhizomes, stems and leaf sheaths, attain an average diameter of 50 cm and a height that may vary from 60 cm to 1 meter.

The hydroseral stages are very numerous The zonation around the "pozzinas", like "Lagoa Bonita", that are very similar to the ones found in the Alps and Corsica, is well-marked. The bottom of this lagoon is an organic coze, over which grow *Isoetes gardneriana* and *I. martii*. The first emergent vegetation is composed of *Juncus microcephalus* and *J. ustulatus* and of several species of *Eriocaulaceae*.

The first helophytic community is a dense floating mat of *Cladium ensifolium*, that is followed by a community of *Cortaderia modesta* and finally by a belt, where the grass, *Cortaderia modesta*, and the bamboo, *Chusquea pinifolia*, grow intermixed.

The ponds are occupied by creeping plants such as: *Boopis itatiaiae, Lilaeopsis ulei, Ranunculus montevidensis* and *Hydrocotyle itatiaiensis*.

The bogs are always of a graminoid type. The ground layer is a continuous carpet of *Sphagnum*. The upper layer is composed exclusively of *Cladium ensifolium*. During the developmental process of the habitat, *Cladium* is gradually replaced by *Cortaderia modesta*. The most advanced communities have the upper stratum composed of a mixture of *Cortaderia modesta* and *Chusquea pinifolia*. Both species, *Cladium ensifolium* and *Cortaderia modesta*, have the same physiognomic aspect and an average height of 2 meters. A special flora grows over the pseudo-trunks of *Cortaderia*. The most frequent species are: *Rhabdocaulon coccineus, Blechnum schomburgkii, Alstroemeria isabellana* and *Polystichum quadrangulare*. The middle layer

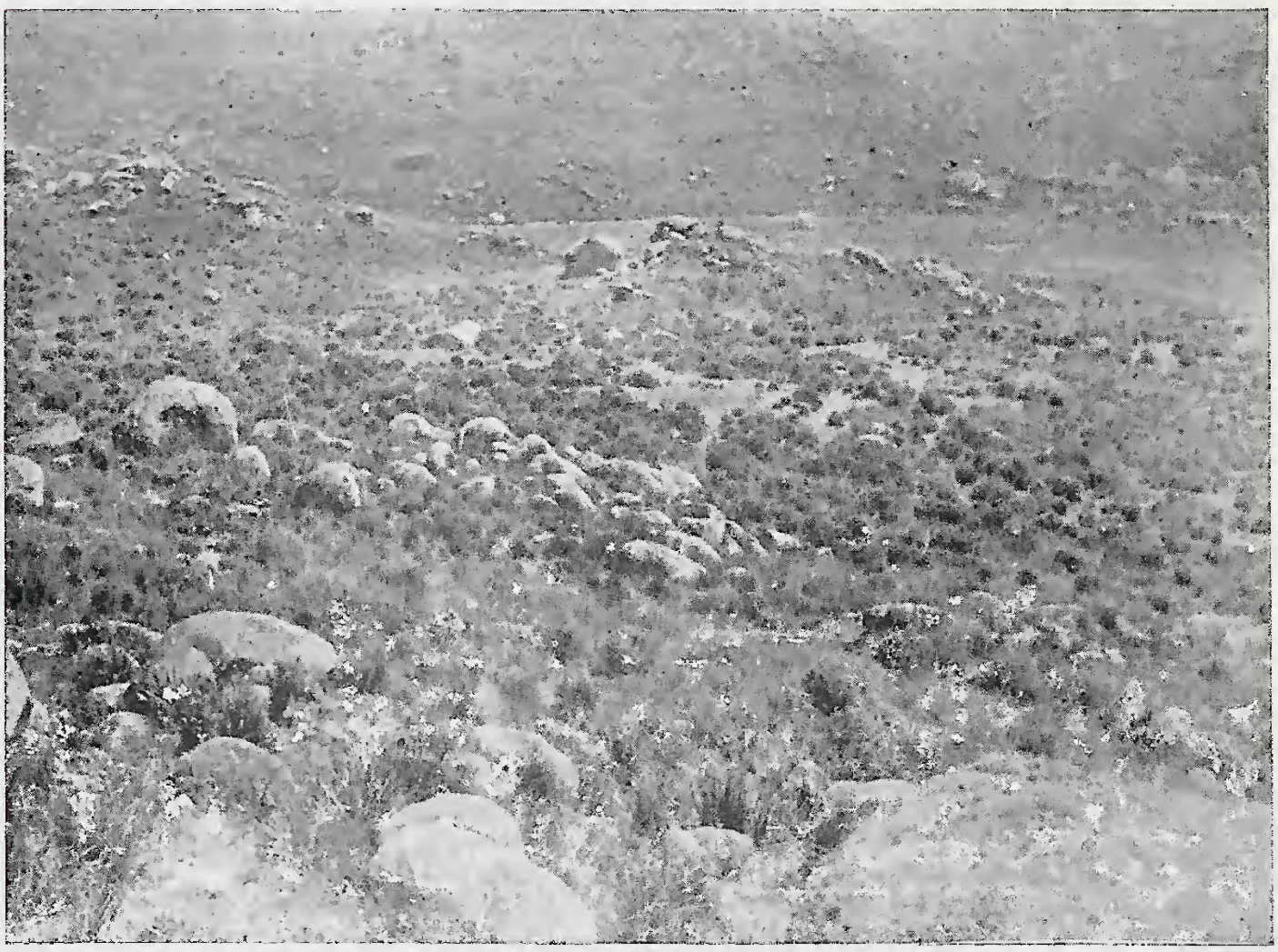

Figure 6 — View over the "Vale das Flores", **Highlands Level**, showing a bog at the bottom of the valley and the characteristic vegetation of the little inclined slopes.

generally has a cover of 20% and its main components are *Xyris* spp., *Bulbostylis* spp., *Eriocaulon* spp., *Leiothrix* spp., and *Cunila galioides*.

The swamps of smaller extent are covered by a graminoid vegetation whose components are species of the genera *Bulbostylis* and *Fimbristylis* associated with several xyridaceous plants. Their height varies from 20 to 30 cm. The lower stratum is occupied either by *Sphagnum*, or by very small plants such as: *Ranunculus montevidensis, Anagallis tenella, Hydrocotyle itatiaiensis* and *Plantago dielsii*, which prevails especially at the margins of these swamps.

The several stream margins are covered by a woody vegetation of an average height of from 60 to 80 cm. The shrubs have dense and spherical crowns that touch the ground. The most frequent shrubby species of these habitats are: *Azara uruguayensis, Myrcia hispida* and *Leucothoe rivularis*. The ground layer is dominated by creeping species such as: *Itatiaia cleistopetala, Geranium brasiliense, Anagallis tenella* and *Blechnum pennamarina*. Alongside these communities, near the water's edge, occurs a dense row of *Cunila galiodes*. In the running but shallow water predominate the submerged communities of *Potamogeton polygonus* and of *Utricularia peltata*.

The innumerable boulders that occur at this level are covered by crustaceous and fruticose lichens. The concave areas formed by rainwater action, are either full of organic matter or of a sandy soil formed "in situ". The sandy pockets are occupied by one-layered communities whose most common dominants are: *Chaetostoma glaziovii, Leucopholis capitata* and *Hippeastrum psittacinum*. The humiferous pockets are occupied, according to the substratum conditions, by several, also one-layered communities. The most frequent are those dominated by the cactus *Zygocactus obtusangulus*, the bromeliaceous *Fernseea itatiaiae* and by the velloziaceous *Barbacenia gounelleana*. These same communities, except the one dominated by the cactus, are frequent on the rocky slopes of medium inclination.

The erosion gullies in the clayish soils, are occupied by a vegetation of ericoid aspect whose upper-layer components are: the melastomaceous, *Chaetostoma glaziovii* and the eriocaulaceous *Paepalanthus polyanthus*. This community is very dense and the *Chaetostoma* crowns attain a maximum height of only 40 cm. During the warm and rainy season, this vegetation is the most conspicuous because of the brilliant flowers, not only of the dominant, *Chaetostoma*, but also of the other components: *Esterhazya splendida, Siphocampylus westinianus* and *Gaultheria ferruginea*.

The open, shallow and well drained valleys, that are surrounded by high hills of round-shaped contours, are occupied by dwarf forests (figs. 5 and 7) whose components, branching near the ground, have an average height of 5 to 6 meters, but sometimes attain 10 meters. Their branches are densely covered by mosses and lichens, and occasionally by bromeliads, *Tillandsia geminiflora var. incana*, being the commonest. The isolated individuals and the ones that grow at the edge of the woods sometimes have their branches densely covered by *Vriesia itatiaiae*. The undergrowth is thin, covering only 10% of the ground; the commonest components are: *Polygala* spp., *Fragaria chiloensis, Carex* sp. and *Geranium brasiliense*. At the tree stratum the dominant species is *Roupala lucens*, and the codominants: *Rapanea schwackeana, R. gardneriana, Weinmannia discolor* and *W. paulliniifolia*.

The deep valleys with almost vertical slopes, have a special microclimate and are occupied by forests of *Araucaria angustifolia*, a relic of the southern flora migration. The few valleys which shelter this type of forest, have a depth varying from 200 to 300 meters. One of the best stations of this type of wood is the one found at the "Vale do Pinheiral", where the trees reach from 25 to 30 meters in height.

The undergrowth layer is sparse, and its most frequent components are the melastomaceous *Leandra sulfurea*, the tree-fern *Alsophila elegans* and the berberidaceous *Berberis laurina*. This forest is undoubtedly, a relic of a climax vegetation which prevailed at this level a long time ago, when the climate was colder and probably moister than the present one.

If we admit that Itatiaia has been glaciated during the Pleistocene, this *Araucaria* forest, has undoubtedly covered great areas after the glacial period. With the advent of a warmer climate the forest has been eliminated, only small colonies remaining in

the deep valleys, and also some isolated individuals in different places over the *Highlands*.

The slopes of these valleys are covered by a shrubby ericoid community, with a graminoid ground layer. The dominants with a height of no more than 30 cm, have a compact and spherical crown, and grow very far from each other. The dominant species is the melastomaceous *Microlicia isophylla*.

In the *Lower Highlands*, situated in the rain-shadow zone, a steppe-like graminoid vegetation dominates. In the valleys and along the rivers, as in other rain-shadow zones, as for example, on the Bocaina Range (State of São Paulo), there occurs a forest dominated by *Podocarpus lambertii*. The trnuks of *Podocarpus* are covered by dense masses of mosses and lichens. The ecological status of this community, especially at Itatiaia, is hard to evaluate. It is undoubtedly, a relic of a vegetation that has covered, in the past, great areas of the massif.

IX — THE SUMMITS LEVEL

This level,, comprising the rocky hills and high peaks of the *Highlands*, has an extremely abrupt topography. The plant communities, even those located in the most favourable places, are subject to extreme conditions of wind, temperature, drainage, and of mechanical and chemical erosion.

The most frequent community, covering a large part of the area, is one dominated by the bamboo, *Chusquea pinifolia*. This bamboo occurs in very dense stands with a maximum height of 1 meter. Its physiognomy is very similar to the one of the *Juniperus* colonies, that occur on the cornices and cliffs of the temperate regions. This community occurs mainly in the humiferous pockets, at

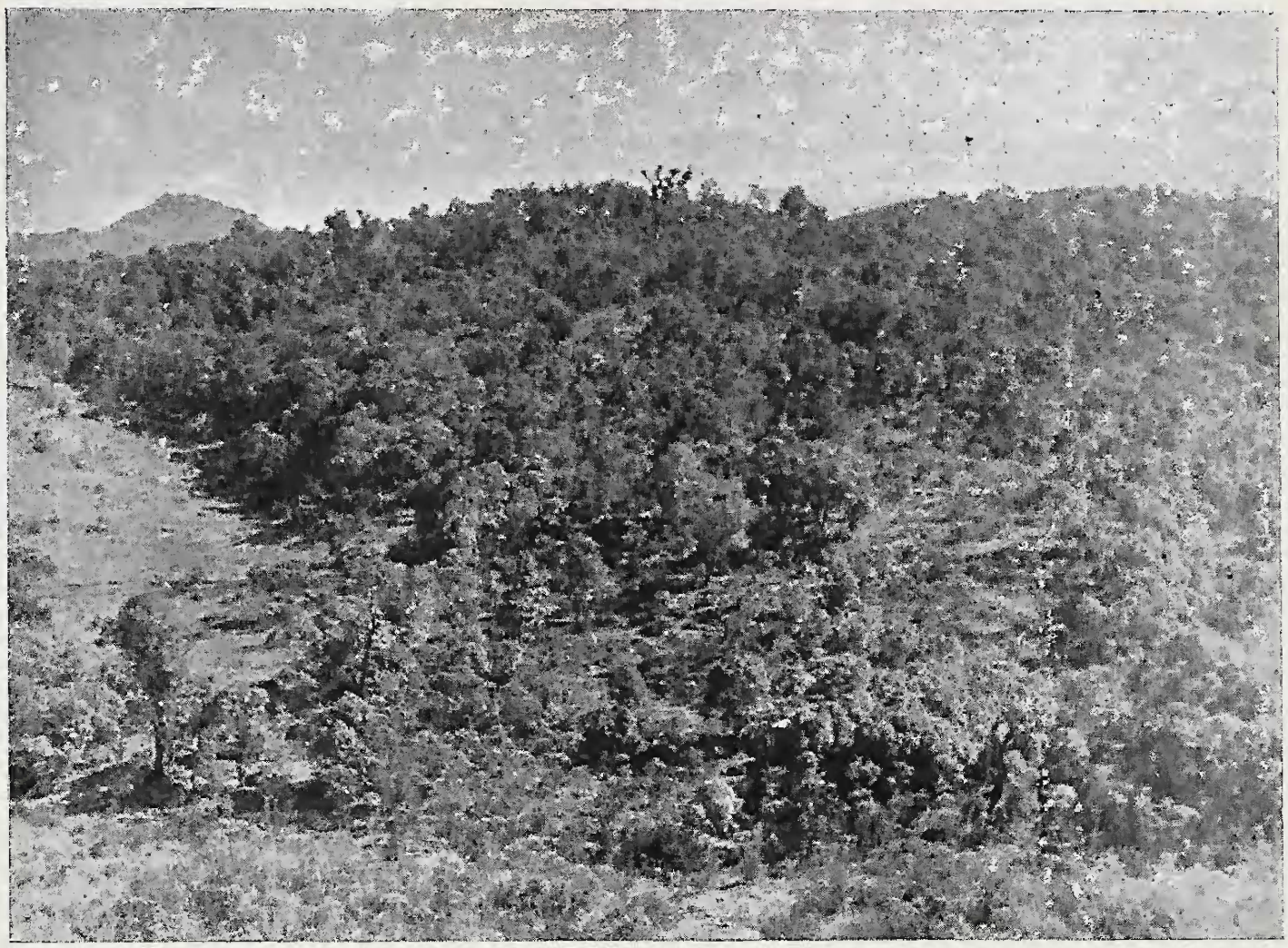

Figure 7 — Dwarf forest dominated by **Roupala lucens**, at the **Highlands Level.**

the rare level places and on the well-protected cornices. It is undoubtedly the climax of this level, in spite of its being an edaphic climax.

In the shady and very humid valleys situated between the highest peaks, and where the drying wind action is insignificant, a very dense shrubby vegetation occurs with from 1.50 to 2 meters of height. The many branched shrubs have rounded crowns that touch the ground. The commonest species are: *Purpurella hospita, Leandra sulfurea, Griselina ruscifolia* and *Myrcia hispida.* Intermixed with these shrubs is frequently found the endemic onagraceous, *Fuchsia campos-portoi.*

On the rough surface and in the crevices of the cliffs, grow several herbaceous and woody plants, all of them of low height or else of the cushion type, such as: *Lepechinea speciosa, Leucopholis capitata, Achyrocline satureoides, Chionolaena glomerata, Lycopodium clavatum,* etc.

At the highest points of the rocky hills, which are relatively flat, although of reduced area, as for instance, on the Agulhas Negras and Prateleiras, where there is decomposed rock, the ground is covered by compact carpets, 10 cm thick, of *Oxalis calva* and of *Zygocactus obtusangulus.* Each one of these species forms an independent community. Where the layer of decomposed rock is deep and contains a certain amount of humus, a community of *Carex purpureo-vaginata* grows. In the shady and humid chimneys, the Andean fern, *Blechnum andinum,* grows in the small crevices, associated with other species such as: *Polypodium tamandarei* and *P. wittigianum.* The crest of the grooves and little inclined slopes, are covered by dense communities of fruticose lichens. At the base of this slope where a certain amount of water accumulates, are found dense colonies of reddish or cream-colored *Sphagnum.*

SUMMARY

The vegetation belts of the Itatiaia massif, six in number, are well delimited and easily recognizable in function of their vegetation structure. There is a direct relationship between the dominant structure of the vegetation and the climate of each of the levels.

From the lowest, the *Plain Level,* as altitude increases, vegetation decreases in height and becomes more and more open. The dominance, at first, is by many species, independent of the dynamic status of the community. However, as altitude increases the number decreases, until it is reduced to a single species. The lianas become rare at the upper levels, while epiphytes increase considerably, especially lichens and mosses, up to the fourth level, where they become reduced to a minimum. In the woods, the middle layers grow less dense and gradually disappear.

The lower level, *Plain Level* (400 to 700 meters), is covered by secondary vegetation, in its pioneer stages. The upper part of this level is occupied by a sub-climax forest, 15 to 20 meters in height, dominated by *Tibouchina estrellensis* and *Cassia multijuga.* The structure and floristic composition of the climax of this level is unknown, because of the complete lack of samples of the primeval forest that once covered the Paraiba valley.

The second level, *Lower Montane Level* (700 to 1,100 meters) is almost completely covered by secondary woods. The commonest are those ones dominated by *Tibouchina estrellensis* and *Cassia multijuga,* and by *Miconia candolleana* and *M. sellowiana.* The climax is an open forest, of poorly-developed undergrowth and a height of 30 to 40 meters. The trees are straight and have thick trunks and buttress roots. The dominants are: *Cariniana excelsa, Cedrela fissilis, Cabralea eichleriana* and *Callichlamis latifolia.*

The *Middle Montane Level* (1,100 to 1,700 meters) and *Upper Montane Level* (1,700 to 2,000 meters) have as their climax, respectively, a forest 20 to 30 meters in height, dominated by species of the genus *Cabralea* and a somewhat open and low forest, 15 meters in height, dominated by *Cabralea eichleriana.*

The *Highlands Level* (2,000 to 2,400 meters) of irregular and varied topography, has as its climax a graminoid vegetation with a steppe structure. The floristic composition of the climax community or communities have not yet been determined. The three types of forest that occur at this level, always in special topographical situations — woods of *Roupala lucens,* woods of *Aracauria angustifolia* and woods of *Podocarpus lambertii* — are relics of the climax vegetation which once occupied the region.

The *Roupala lucens* forests are relics of a period when the climate was warmer and moister than the present one, while the *Araucaria angustifolia* woods are relics of a climax which existed under a colder and probably rainier climate than the present one.

The ecological status of the *Podocarpus lambertii* woods is hard to define. They are, probably, relics of a climax or sub-climax which covered great areas of the massif, when the dominant climate was colder (the same average temperature as for *Araucaria angustifolia*) and drier than the present one.

On the last level, *Summits* (2,400 to 2,770 meters) the most frequent vegetation is the community dominated by a dwarf bamboo, *Chusquea pinifolia*, whose individuals are never more than 1 meter high. This community is undoubtedly the climax, in spite of its being an edaphic one.

Ecological studies on the Itatiaia massif are still incomplete, especially in regard to the *Highlands Level*, but we hope in a near future, to clarify some of the main problems which we have outlined above.

SUMÁRIO

Os andares de vegetação no maciço do Itatiaia, em número de seis, são bem delimitados e fàcilmente reconhecíveis em função da estrutura da vegetação que os cobre.

A partir do andar mais baixo, *Planície*, a medida que aumenta a altitude, a vegetação diminue em porte e se torna mais aberta. A dominância que é exercida a princípio por várias espécies, qualquer que seja o estatus dinâmico da comunidade, passa, com o aumento da altitude a ser exercida por poucas espécies ou mesmo por uma única. As lianas tornam-se raras nos andares superiores enquanto que o epifitismo aumenta consideràvelmente até o quarto andar, sobretudo o de liquens e musgos, quando então desaparece. Nas matas, os estratos intermediários tornam-se menos densos e desaparecem paulatinamente.

O andar mais baixo, *Planície* (400 a 700 metros), é hoje coberto por vegetação secundária em seus estágios pioneiros. Sua parte superior é ocupada por uma floresta subclimax, de 15 a 20 metros de altura, dominada por *Tibouchina estrellensis* e *Cassia multijuga* A estrutura e composição florística do climax dêste andar é inteiramente desconhecida por não mais existirem testemunhas da floresta que outrora cobria o vale do Paraíba.

O segundo andar, *Montanha Inferior* (700 a 1.100 metros), é quase totalmente recoberto por matas secundárias, sendo as mais comuns as dominadas por *Tibouchina estrellensis; Cassia multijuga* e *Miconia candolleana; Miconia sellowiana*. O climax é uma floresta aberta, de sub-bosque pouco denso, com um porte de 30 a 40 metros, constituída por árvores de troncos grossos, retilíneos e raízes tabulares. A dominância é exercida por *Cariniana excelsa, Cedrela fissilis, Cabralea eichleriana* e *Callichlamis latifolia*.

Os andares, *Montanha Média* (1.100 a 1.700 metros) e *Montanha Superior* (1.700 a 2.000 metros) têm por climax, respectivamente, uma floresta de 20 a 30 metros de altura, dominada por espécies do gênero *Cabralea*, e uma floresta pouco densa, baixa, com não mais de 15 metros de altura, dominada por *Cabralea eichleriana*.

O penúltimo andar, *Planalto* (2.000 a 2.400 metros), de topografia irregular e bastante variada, tem por climax uma vegetação graminóide com estrutura de estepe. A comunidade ou comunidades climax não foram ainda determinadas com precisão quanto à sua composição florística. Os três tipos de mata que ocorrem neste andar, sempre em situações topográficas especiais: matas de *Roupala lucens*, de *Araucaria angustifolia* e de *Podocarpus lambertii*, são relíquias das vegetações climax que ocuparam a região em épocas passadas.

As matas de *Roupala lucens* são relíquias de um período em que o clima era mais quente e úmido que o atual, enquanto que as matas de *Araucaria angustifolia* são relíquias de um climax que existiu debaixo de um clima mais frio, e, provàvelmente, mais chuvoso que o da atualidade.

O estatus ecológico das matas de *Podocarpus lambertii* é difícil de precisar, mas é de se supor que sejam relíquias de um climax ou de um sub-climax que cobriu grandes áreas do maciço em uma época em que o clima dominante era mais frio (igual a aquêle sob o qual dominou *Araucaria angustifolia*) e mais sêco que o de hoje.

No último andar, *Cumes* (2.400 a 2.770 metros) a vegetação predominante é uma comunidade, dominada por um bambú anão, *Chusquea pinifolia*, cujos indivíduos têm um

porte que não ultrapassa um metro. Esta comunidade é sem dúvida alguma o climax, ainda que seja um climax edáfico.

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APPENDIX

LIST OF AUTHORS AND FAMILIES OF THE CITED SPECIES

Abutilon	Malvaceae
Achyrocline satureioides DC.	Compositae
Aechmea	Bromeliaceae
Alsophila elegans Mart.	Cyatheaceae
Alstroemeria isabellana Herb.	Amaryllidaceae
Anagallis tenella L.	Primulaceae
Andropogon incanus Hack.	Gramineae
Anthurium	Araceae
Araucaria angustifolia O. Ktze.	Araucariaceae
Arrabidaea	Bignoniaceae
Asplenium	Polypodiaceae
Astrocaryum aculeatissimum Burret = A. ayri Mart.	Palmae
Attalea indaya DC.	Palmae
Azara uruguayensis (Speg.) Sleumer.	Flacourtiaceae
Baccharis discolor Bak.	Compositae
Baccharis platypoda DC.	Compositae
Baccharis schultzii Bak.	Compositae
Barbacenia gounelleana Beauv.	Velloziaceae
Bauhinia	Leguminosae
Berberis laurina Billb.	Berberidaceae
Blechnum andinum (Bak.) C. Chr.	Polypodiaceae
Blechnum penna-marina (Poir.) Kuhn.	Polypodiaceae
Blechnum schomburgkii (Kl.) C. Chr.	Polypodiaceae
Bombax	Bombacaceae
Borreria	Rubiaceae
Boopis itatiaiae Dusen	Calyceraceae
Briza brasiliensis (Nees.) Ekm.	Gramineae
Bromus brachyanthera Doell.	Gramineae
Buddleia	Loganiaceae
Bulbostylis	Cyperaceae
Cabralea eichleriana C.Dc.	Meliaceae
Calamagrostis montividensis Nees.	Gramineae
Calathea	Maranthaceae
Callichlamys latifolia K. Schum.	Bignoniaceae
Canna	Cannaceae
Canella	Canellaceae
Capsicum	Solanaceae
Carex purpureo-vaginata Boeck.	Cyperaceae
Cariniana excelsa Casar.	Lecythidaceae
Cassia multijuga Rich.	Leguminosae
Cedrela fissilis Vell.	Meliaceae
Cecropia	Moraceae
Cestrum	Solanaceae
Chaetostoma glaziovii Cogn.	Melastomataceae

Chionolaena glomerata Bak.	Compositae
Chusquea pinifolia Nees.	Gramineae
Cladium ensifolium Benth.	Cyperaceae
Clethra laevigata Meissn.	Clethraceae
Clidemia neglecta D. Don.	Melastomataceae
Clytostoma	Bignoniaceae
Coccoloba	Polygonaceae
Coccocypselum	Rubiaceae
Codonanthe	Gesneriaceae
Copaifera	Leguminosae
Cordia curassavica Roem.	Borraginaceae
Cortaderia modesta (Doell.) Hack.	Gramineae
Corytholoma	Gesneriaceae
Costus	Zingiberaceae
Couratari	Lecythidaceae
Croton salutaris Casar.	Euphorbiaceae
Croton urucurana Baill.	Euphorbiaceae
Cunila galioides Benth.	Labiatae
Cuphea	Lythraceae
Cyathea gardneri Hook.	Cyatheaceae
Cybistax	Bignoniaceae
Danthonia montana Doell.	Gramineae
Deschampsia	Gramineae
Dichorisandra	Commelinaceae
Dicksonia sellowiana Hoek.	Cyatheaceae
Diodia	Rubiaceae
Drimys winteri Forst.	Magnoliaceae
Eriocaulon	Eriocaulaceae
Erythrina mulumgu Mart.	Leguminosae
Erythroxylum	Erythroxylaceae
Esterhazya splendida Mik.	Scrophulariaceae
Eugenia	Myrtaceae
Eupatorium	Compositae
Euterpe edulis Mart.	Palmae
Fernseea itatiaiae (Wawra.) Bak.	Bromeliaceae
Festuca	Gramineae
Fimbristylis	Cyperaceae
Fragaria chiloensis (L.) Erh.	Rosaceae
Fuchsia campos-portoi Pilger. & Shulze.	Onagraceae
Gaultheria ferruginea Cham. & Schlecht.	Ericaceae
Geonoma barbosana Burret.	Palmae
Geonoma schottiana Mart.	Palmae
Geranium brasiliense Prog.	Geraniaceae
Gleichenia	Gleicheniaceae
Griselina ruscifolia (Clos.) Taub.	Cornaceae
Guadua	Gramineae
Haemocharis semisserrata Mart. & Zucc.	Theaceae
Hariota	Cactaceae
Heliconia	Musaceae
Hemitelia capensis R. Br.	Cyatheaceae
Herreria	Liliaceae
Heteropteris	Malpighiaceae
Hippeastrum psittacinum Herb.	Amaryllidaceae
Hortia arborea Engl.	Rutaceae
Hydrocotyle itatiaiensis Brade.	Umbelliferae
Hymenophyllum	Hymenophyllaceae
Hypocyrta	Gesneriaceae
Itatiaia cleistopetala Ule.	Melastomataceae
Inga affinis Steud.	Leguminosae
Isoetes gardneriana A. Br.	Isoetaceae
Isoetes martii A.Br.	Isoetaceae
Jacaranda	Bignoniaceae
Juncus microcephalus H.B.K.	Juncaceae
Juncus ustulatus Buchen.	Juncaceae
Leandra sulfurea Cogn.	Melastomataceae
Leiothrix	Eriocaulaceae
Lepechinea speciosa (St. Hil.) Epig.	Labiatae
Leucopholis capitata (Bak.) Cuffod.	Compositae

Leucothoe rivularis Sleumer.	Ericaceae
Lilaeopsis ulei Perez-Moureau.	Umbelliferae
Lycopodium clavatum L.	Lycopodiaceae
Machaerium	Leguminosae
Mandevilla	Apocynaceae
Maranta	Marantaceae
Melinis minutiflora Beauv.	Gramineae
Meriania claussenii Triana.	Melastomataceae
Merostachys	Gramineae
Miconia candolleana Naud.	Melastomataceae
Miconia sellowiana Naud.	Melastomataceae
Microlicia isophylla DC.	Melastomataceae
Myrcia hispida Berg.	Myrtaceae
Nectandra	Lauraceae
Nicotiana	Solanaceae
Olyra	Gramineae
Ouratea	Ochnaceae
Oxalis calva Prog.	Oxalidaceae
Paepalanthus polyanthus Kunth.	Eriocaulaceae
Palicourea	Rubiaceae
Panicum demissum Doell.	Gramineae
Panicum setifolium Nees.	Gramineae
Pavonia	Malvaceae
Peperomia	Piperaceae
Pharus	Gramineae
Philodendron	Araceae
Pilea	Urticaceae
Piptadenia nitida Benth.	Leguminosae
Pisonia nitida Mart.	Nyctaginaceae
Plantago dielsii Pilger.	Plantaginaceae
Podocarpus lambertii Klotzsch.	Podocarpaceae
Polygala	Polygalaceae
Polypodium tamandarei Rosenst.	Polypodiaceae
Polypodium wittigianum Fée.	Polypodiaceae
Polystichum quadrangulare Fee.	Polypodiaceae
Potamogeton polygonus Cham.	Potamogetonaceae
Psychotria hancorniaefolia Benth.	Rubiaceae
Purpurella hospita Cogn.	Melastomataceae
Qualea	Vochysiaceae
Quesnelia	Bromeliaceae
Ranunculus montevidensis Arech.	Ranunculaceae
Rapanea gardneriana (A.DC.) Mez.	Myrsinaceae
Rapanea schwackeana Mez.	Myrsinaceae
Rhabdocaulon coccineus (Benth.) Eplg.	Labiatae
Rhipsalis	Cactaceae
Rhynchospora	Cyperaceae
Roupala lucens Meissn.	Proteaceae
Sauvagesia	Violaceae
Schinus terebinthifolius Raddi.	Anacardiaceae
Sclerolobium rugosum Mart.	Leguminosae
Scleria	Cyperaceae
Selaginella	Selaginellaceae
Senecio glaziovii Bak.	Compositae
Sida	Malvaceae
Siphocampylus westinianus (Billb.) Pohl.	Campanulaceae
Smilax	Liliaceae
Solanum itatiaiae Dusen.	Solanaceae
Sphagnum	Sphagnaceae
Strychnos	Loganiaceae
Tecoma	Bignoniaceae
Tibouchina arborea Cogn.	Melastomataceae
Tibouchina estrellensis Cogn.	Melastomataceae
Tibouchina fissinervia Cogn.	Melastomataceae
Tibouchina organensis Cogn. var. silvestris Brade.	Melastomataceae
Tillandsia geminiflora var. incana (Wawra.) Mez. = Tillandsia incana Wawra.	Bromeliaceae
Trachypogon	Gramineae

Trichomanes	Hymenophyllaceae
Triumfetta	Tiliaceae
Utricularia peltata Spruce.	Lentibulariaceae
Vernonia diffusa Less.	Compositae
Vernonia oppositifolia Less.	Compositae
Virola bicuhyba (DC) Warm.	Myristicaceae
Vittaria	Polypodiaceae
Vochysia	Vochysiaceae
Vriesia itatiaiae Wawra.	Bromeliaceae
Weinmannia discolor Gard.	Cunoniaceae
Weinmannia paulliniifolia Pohl.	Cunoniaceae
Xyris	Xyridaceae
Xylopia brasiliensis Spreng.	Anonaceae
Zygocactus obtusangulus (Lindb.) Loefgr.	Cactaceae